REMARKS

Rejections under 35 USC §103(a)

Claims 1-4 were rejected under 35 USC §103(a) as being obvious over Schetzina (U.S. Patent No. 5,679,965) in view of White et al. (U.S. Patent No. 6,291,085) and Applicants' Admitted Prior Art .

Applicants respectfully traverse the rejection.

Admitting that the combination of Schetzina and White does not teach the p-type single crystal ZnO comprises 1 to 99 mol% manganese, the Examiner alleged as follows:

> Admission teaches to achieve a ferromagnetic state with a high ferromagnetic transition temperature by doping Mn into ZnO, it is required to heavily dope a hole (p-type carrier) having an interactional function for ferromagnetically uniform the spin in Mn doped into ZnO being a wide-gap semiconductor. Admission also teaches a single crystal ZnO doped with Mn having a high ferromagnetic transition temperature enables high density magnetic recording medium capable of transmitting larger amounts of information. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the heavily doped p-type ZnO single crystal taught by the combination of Schetzina and White et al with Admission's method of doping Mn into a ZnO crystal because a ZnO film doped with Mn can be used as a high-density magnetic recording medium.

The relevant portion of the present specification, as amended, describes as follows:

DISCLOSURE OF INVENTION

Problems Solved By The Invention

> Achieving a single-crystal ZnO thin film doped with Mn having a high ferromagnetic-transition temperature ~~enables~~ would enable providing optical isolators or high-density magnetic recording medium capable of transmitting larger amount of information, and ~~makes~~ would make it possible to fabricate a desirable electronic industry material required for oncoming large-scale information transmission. ZnO also has a large band gap of 3.3 eV. This opens the way to fabricate a light-transmittable ferromagnetic material, which may facilitate the extensive evolution of manufacturing technologies for optical devices, such as a photon computer utilizing a coherent spin state.
>
> For achieving a ferromagnetic state with a high ferromagnetic-transition temperature by doping Mn into ZnO, it is required to heavily dope a hole (p-type carrier) having an interactional function for ferromagnetically uniform the spin in Mn doped into ZnO being a wide-gap semiconductor.

The headline "Problems Solved By The Invention," which was in the original specification of the international application was omitted in the English translation as being considered that such arrangement would not affect the content of the disclosure. (attached is a copy of the relevant portion of PCT application, filed in the Japanese Patent Office, highlighting the portion which was left out by this translation). Thus, this portion is an explanation of the problem to be solved by the present invention, and nothing in the description indicates that such a single-crystal ZnO is known. The specification has been amended to insert the head line to clarify the nature of the description and placed under the headline of "DISCLOSURE OF INVENTION." Thus, the alleged "Applicants' Admitted Prior Art" is not prior art.

Also, the Examiner's allegation heavily depends on the alleged "Applicants' Admitted Prior Art" to show the suggestion or motivation of combining the prior art references. Because

the alleged "Applicants' Admitted Prior Art" is not prior art, the combination of Schetzina and White et al. does not establish a prima facie case of obviousness.

For at least these reasons, claims 1-4 patentably distinguish over the prior art.

Double Patenting

Claims 1 and 2 were rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-11 of U.S. Patent No. 6,527,858 in view of Applicants Admitted Prior Art.

Claims 3 and 4 were rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-11 of U.S. Patent No. 6,527,858 in view of Applicants Admitted Prior Art, and further in view of Schetzina (U.S. Patent No. 5,679,965).

The previously filed terminal disclaimer was not accepted by the Examiner due to a formality matter. Another terminal disclaimer is submitted herewith correcting the formality error.

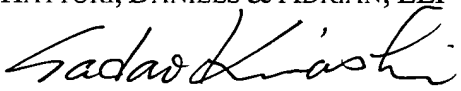
In view of the aforementioned amendments and accompanying remarks, Applicants submit that that the claims, as herein amended, are in condition for allowance. Applicants request such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

WESTERMAN, HATTORI, DANIELS & ADRIAN, LLP



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Attachments: A copy of the relevant portion of the specification of the PCT international application filed in Japan
Corrected Terminal Disclaimer

明　細　書

1 強磁性ｐ型単結晶酸化亜鉛およびその製造方法

技術分野

本発明は、Ｍｎをドープした強磁性ｐ型単結晶酸化亜鉛（ＺｎＯ）およびその製造方法に関するものである。

背景技術　BACKGROUND OF THE INVENTION

酸化亜鉛は、半導性、光導電性、圧電性等を有し、圧電体材料やオプトエレクトロニクス材料への適用のための透明性と結晶軸配向性を有する酸化亜鉛をスパッタリング法やＣＶＤ法で製造する方法が知られている（特開平５－２５４９９１号公報）。また、原料酸化亜鉛にドーピング物質をドーピングして導電性または絶縁性透明酸化亜鉛を製造する方法も公知である（特開平５－７０２８６号公報）。さらに、酸化亜鉛を主成分とする単結晶からなる圧電性半導体を製造する方法として水熱法が知られている（特開平６－２７９１９２号公報、特開平６－２７９１９３号公報等）。しかし、酸化亜鉛について、強磁性状態の実現の報告はこれまでにみられない。

（発明が解決しようとする課題）(Problems Solved By The Invention)

強磁性転移温度の高いＭｎをドープした単結晶ＺｎＯ薄膜が合成できれば、大量情報の伝達に必要な光アイソレータや高密度磁気記録が可能になり、将来の大量情報伝達に必要な電子材料を作成することができる。また、ＺｎＯのバンドギ

ャップは３．３ｅＶと大きく、光を通す強磁性体の作製が可能になり、コヒーレントなスピン状態を利用した光量子コンピュータなどの光デバイス作製技術の大きな発展が期待される。

ＺｎＯにＭｎをドープして、高い強磁性転移温度をもつ強磁性状態を実現するためには、ワイドギャップ半導体であるＺｎＯにドープしたＭｎのスピンを強磁性的に揃えるための相互作用となるホール（ｐ型キャリアー）を高濃度にドープする必要がある。

（課題を解決するための手段）(Means for Solving The Problems)

本発明者は、上記の課題を解決するためにｐ型ドーパントを単独またはｐ型ドーパントとｎ型ドーパントを同時にドーピングすることによる新しい価電子制御法を開発し、ＺｎＯにドープしたＭｎのスピンを高濃度にドープしたホールの遍歴的な運動エネルギーによるエネルギー利得により、強磁性的に揃えることに成功した。

すなわち、本発明は、強磁性の担い手である遷移金属元素であるＭｎとｐ型ドーパント（ホール）を含有している強磁性ｐ型単結晶酸化亜鉛（ＺｎＯ）である。

ＭｎをドープしたＺｎＯにｐ型ドーパントがドープされていると遍歴的なホールによる運動エネルギーの低下により、反強磁性や常磁性状態よりも強磁性状態を安定化させる原理により、安定で強磁性臨界温度の高いｐ型単結晶酸化亜鉛が得られる。

さらに本発明は、強磁性の担い手である遷移金属元素であるＭｎとｐ型ドーパント（ホール）を含有しているｐ型の強磁性単結晶ＺｎＯにおいて、Ｍｎ間の磁気的相互作用を強磁性体化するため、ｐ型化を実現し大量の遍歴的ホールを増大